A CASE STUDY OF THE PLANNING AND IMPLEMENTATION OF PRODUCTION READINESS REVIEWS FOR SELECTED WEAPON SYSTEMS WITHIN AIR FORCE SYSTEMS COMMAND

THESIS

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Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Contract Management

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September 1989

Approved for public release; distribution unlimited

Acknowledgements

I would like to offer my sincere gratitude and appreciation to my wife and children for their understanding and support during this long and arduous year. Thanks for putting up with my long hours, late nights, and too frequent bad moods. I couldn't have done it without you. I hope you all enjoyed your summer vacations without me. Well, not too much!

I would also like to thank my thesis advisor, Major Mike Farr, for keeping me on track and within cost, schedule, and performance thresholds.

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List of Acronyms

AFB	Air Force Base
AFSARC	Air Force System Acquisition Review Council
AFSC	Air Force Systems Command
ASD	Aeronautical Systems Division
BMO	Ballistic Missile Office
BSD	Ballistic Systems Division (Formerly BMO)
CAO	Contract Administration Organization
CAS	Contract Administration Service
CDR	Critical Design Review
DAB	Defense Acquisition Board
DOD	Department of Defense
DSARC	Defense System Acquisition Review Council
DSB	Defense Science Board
ESD	Electronic Systems Division
FSD	Full Scale Development
GAO	General Accounting Office
HSD	Human Systems Division
LRIP	Low Rate Initial Production
MIL-STD	Military Standard
MSD	Munition Systems Division (Formerly AD)
PRR	Production Readiness Review
RFA	Request For Action
SOW	Statement of Work
SPO	System Program Office
SSD	Space Systems Division

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Abstract

The purpose of this study was to determine how Production Readiness Reviews (PRR) were planned, implemented, and managed by selected programs within Air Force Systems Command. In 1983, the Defense Science Board was tasked with reviewing ways to improve and accelerate the transition of weapon systems into production. During 1985, the General Accounting Office reviewed why some weapon systems encounter production problems while others do not. Both studies provided recommendations on ways to improve the transition process. However, new production programs continue to suffer significant production problems which invariably result in cost increases and schedule delays.

This study reviewed ten programs which recently conducted PRRs in an attempt to look at actual PRR practices and factors which influenced the selection of these practices. In addition, an attempt was made to determine whether recommendations from the DSB and GAO studies were implemented. Included in this study were reviews of PRR Plans, PRR Reports, Contract Statements of Work, and PRR briefings. In addition, key managers were interviewed for their views of the PRR process and recommendations for changes.

Based on the data from this study, it was apparent that all ten programs met the basic DOD requirements for PRR

implementation. However, DOD Regulations and Directives did not provide sufficient guidance on planning and managing PRRs. The result was several different planning approaches that were generally dependent on program size, cost, and complexity. The degree of experience and expertise of program office personnel also played a significant role in PRR planning. The different approaches taken and the factors influencing these approaches are provided in Chapter III. Specific conclusions and recommendations are provided in Chapter IV.

A CASE STUDY OF THE PLANNING AND IMPLEMENTATION OF PRODUCTION READINESS REVIEWS FOR SELECTED WEAPON SYSTEMS WITHIN AIR FORCE SYSTEMS COMMAND

I. Introduction and Objective

Introduction

In a 1981 memorandum to the Secretaries of the Military Departments, then Secretary of Defense, Caspar Weinberger, stated that

> Too often in the past, when faced with funding and schedule constraints, we have compromised the technical integrity of our programs by deleting or deferring vital program elements that contribute to system performance, producibility, and supportability. We have added unintentionally to the life cycle cost and postponed effective operational capability dates by pursuing development programs which do not yield producible designs and supportable configuration in a timely manner. (1:1)

The transition a weapon system makes from the development phase to production is critical to its becoming a successful acquisition. A weapon system is prepared for production during this transition process. Emphasis is placed on finalizing the design of the system; establishing effective test measurements for the system's successful performance; and certifying manufacturing planning and processes to produce the system. As indicated, this transition is a process, not a discrete, event whose success is measured by passing a milestone review at the end of the development phase. Rather, transition is a culmination of efforts in preparing the system for production. Ideally, this

transition process should start early in the full-scale development (FSD) phase and continue to full-rate production. The transition process is very broad and is highly influenced by the extent of production planning early in the development phase. Therefore, management of weapon systems from the development phase through production requires effective management and coordination across many functions of program management.

The Department of Defense (DOD) policy regarding production management reflects the importance of early production planning and the critical nature of the transition process. DOD Directive 4245.7, "Transition of Weapon Systems from Development to Production," states the DOD policy that production risks be identified as early as possible; that these risks be reduced before a production decision; that production engineering and production planning be done throughout FSD; that voids in production technologies be identified and addressed; and that before proceeding into production, contractors demonstrate the capabilities to produce within cost and on schedule (2:1-5).

One of the most important reviews used by DOD during the transition process is the Production Readiness Review (PRR). The objective of the PRR is to determine if the weapon system design, production planning, and associated preparations for producing the system have progressed to a point where a production commitment can be made without incurring unacceptable risks of breaching the thresholds of

cost, schedule, or performance (3:1). The PRR consists of a team of experts from the various functions of program management and are usually selected from the System Program Office (SPO), Contract Administration Office (CAO), and other functions as required.

The typical PRR will examine the design of the weapon system for completeness and producibility. More specifically, the team will review the contractor's production planning, existing and planned facilities, tooling, manufacturing methods, material and manpower resources, production engineering, and overall production management (3:3). At the completion of the review, the PRR team director issues a report to the weapon system program manager which summarizes potential risks in each area, production deficiencies, and an overall assessment of transition activities. The program manager includes this evaluation in his assessment of program performance and risk to the required higher level review boards as determined by program size (4:2). DOD policy requires that a PRR be conducted prior to the start of production, including low rate initial production (LRIP) during FSD.

Recent years have witnessed an increasing emphasis in upgrading producibility, reliability, and maintainability of new weapon systems being procured by DOD. This increased interest can be attributed primarily to the skyrocketing costs of new weapon systems and Congressional pressure to reduce costs. Even with the renewed interest in the

transition process, many of the sophisticated weapon systems being procured today continue to experience problems during the production phase that result in cost growth and schedule delays. The need for high-technology weapons coupled with design and producibility problems have invariably resulted in DOD receiving systems less capable than the original requirements and at a greater cost.

In 1982, the Defense Science Board (DSB) was tasked to address similar issues. In addition to the escalating cost of weapon systems and budget pressures was the unsatisfactory effectiveness of producing these systems. Consequently, a DSB Task Force on "Transition of Weapons Systems from Development To Production" was organized to review, evaluate, and make recommendations on ways to improve and accelerate the transition of weapon systems into production. The task force concluded that the causes of acquisition risk in the transition from development to production of weapon systems were more technical in nature than managerial. In other words, reorganizing the milestones of the acquisition process was not the answer. The Task Force also concluded that reducing these acquisition risks requires the approach of designing the system with production in mind. Too often, weapon systems with inherent design deficiencies were allowed to transition into production with hopes that unproven manufacturing technologies would improve the system's producibility. The DSB recommendation to correct this situation is a disciplined engineering department

that interfaces with manufacturing engineering early in the program to ensure a producible design before entering production (4:1-3).

The DSB Task Force developed a matrix of the most critical events in the design, test, and production elements of the production process. From this matrix of critical events, a set of templates were developed which identify different levels of technical risk and describe techniques for reducing or eliminating these risks These templates reflect the experience and knowledge of highly respected experts from the defense industry that participated in the DSB study on transition. The DSB then recommended the use of these templates as a tool to assist in the transition of weapon systems into production (4:1-6).

Justification for Research

The critical nature of the transition of weapons into production and the importance of the PRR are further emphasized by the large financial commitments that typically accompany a production decision. Approximately one-half of the overall defense budget is accounted for in the production phase of weapon system acquisition (5:1). However, it is also during this phase that weapon system producibility problems usually arise or production planning deficiencies are detected. These problems usually result in engineering design changes or lower production yields which, in turn, drive production costs up and delay delivery schedules.

The objective of PRRs is to ensure that both the weapon system design and contractor are prepared to enter into production with acceptable cost, schedule, and performance risks holds (2:11-4). Several sources suggest that in general, this objective is not being met.

First, cost overruns and schedule delays on major weapon systems continue to fill newspaper headlines. More recently, the Air Force B-2 bomber and the Peacekeeper inter-continental ballistic missile (MX) programs have come under fire for significant design problems, test failures, schedule delays and cost increases. Second, problems similar to these were reflected in the 1985 General Accounting Office (GAO) study entitled "Why Some Weapon Systems Encounter Production Problems and Others Do Not." In their study, GAO investigators concluded that inadequate production preparations during the development phase led to problems in production. In four of six case studies of weapon system acquisitions, production preparations were sporadic, underfunded, and conducted too late in the development phase (6:ii). Additionally, PRRs were applied quite differently in the six programs. In some cases, PRRs were used to assess production readiness and manage concerns and risks while in others they were viewed as a "gate to pass through" or a "square to fill" before production (6:27). The programs that did not use PRRs as a tool in managing program production readiness and risks suffered significant cost and schedule problems. From their study,

the GAO recommended using PRRs as a tool for managing production preparations to progressively reduce production risks. In addition, GAO investigators recommended that PRRs be conducted at intervals beginning early in FSD and they be continued throughout preparations for full-rate production (6:vii).

The GAO recommendations on implementation of PRRs coupled with the use of the transition templates from the DSB study should have provided a means of reducing production risks, schedule delays, and cost overruns.

Research Objective

The specific objectives of this research are:

1. Review how PRRs are planned and implemented during the transition from development to production of selected weapon systems within Air Force Systems Command (AFSC).

2. Determine if the recommendations on PRR implementation and management from the 1985 GAO study were implemented.

3. Review how the transition templates from the 1982 DSB study are being applied in the PRR process.

The following investigative questions will be answered to help achieve these research objectives.

Investigative Questions

1. How are PRRs implemented and managed by the different programs among the product divisions of AFSC?

2. Is there adequate guidance and direction provided in DOD and Air Force Directives and Regulations for planning and implementing PRRs?

3. What criteria, policies, or procedures are currently used by the different program management offices in assessing the readiness of their weapon system and contractor to begin production?

4. Do these criteria, policies, and procedures reflect the recommendations of the 1985 GAO study and 1982 DSB study regarding transition into production?

5. How are the transition templates from DOD Manual 4245.7, "Transition From Development to Production," applied to PRRs by selected program management offices?

6. What contractual requirements are placed on the contractor to plan for and support PRRs?

7. Of what perceived value are PRRs to program managers in transitioning their programs into production?

Scope and Limitations

Although each of the branches of service within DOD manage major weapon systems acquisitions, each has a different management structure and program management offices spread across the country. Due to resource constraints, this research will be limited to those weapon systems acquisitions managed by the Air Force. However, all DOD weapon system acquisitions must adhere to DOD Directives and Regulations. Therefore, it is felt that this study will provide a generalization of the implementation and management practices of PRRs based on the applicable DOD policies, directives, and actual practices.

Summary

Chapter I introduced the process a weapon system undergoes as it transitions from full-scale development to production, and the critical importance of this transition

process in determining the success of the program. In addition, PRRs were introduced as the most visible tool used by DOD in determining the readiness of a weapon system and its producer to enter the production phase. The importance of the transition process and PRRs was further reinforced by the findings from the 1982 DSB and 1985 GAO studies regarding transition. Next, the justification for the research was reinforced with evidence of programs encountering production problems stemming from failure to use PRRs as a management tool during development. Also, the research objective of determining how PRRs are planned and implemented among the different programs within AFSC was introduced. A review of whether the recommendations were implemented from both the 1982 DSB study and the 1985 GAO study is included in the research objective. Finally, the scope and limitations of this research were delineated.

II. Literature Review and Research Methodology

Overview

This chapter describes the DOD acquisition cycle with its five phases and corresponding milestones. Next, the transition of weapon systems from development to production is discussed including when and where it occurs during the acquisition cycle. The PRR is then described in detail including its importance as a tool for DOD to determine production readiness during transition. Two DOD studies concerning transition risks and production problems are discussed including conclusions and recommendations to preclude future problems. Following this discussion is a description of AFSC and its six product divisions with its mission of developing, acquiring, and delivering weapon systems the Air Force needs to meet its mission. Finally, the methodology used to conduct this research is discussed to close out the chapter.

Literature Review

Weapon System Acquisition. Weapon system acquisition is a complex and critical process in the DOD with significant impacts on both national defense and the national budget. The efficiency and effectiveness of this process determines how well U.S. taxpayers' money is spent or, in the vernacular, how much "bang for the buck" is achieved.

DOD policy for major weapon system acquisition is outlined in DOD Directive 5000.1, "Major and Non-Major Defense Acquisition Programs." The directive states in part:

> The policy of the Department of Defense is to assure that the DOD Acquisition System functions in a timely, efficient and effective manner to achieve the operational objectives of U.S. Armed Forces in support of national policies and objectives. (7:3)

Implementation and management of the weapon system acquisition process normally occurs in five phases. These phases enhance management effectiveness and can be tailored for each system to minimize acquisition time and life cycle costs. The tailoring of these phases are primarily dependent on urgency of need, degree of technical risk, and demonstrated progress of the weapon system (8:2). The end of each phase of acquisition coincides with a milestone decision to either enter the next phase of acquisition or end the program. This milestone decision for major DOD programs is ultimately made by the Secretary of Defense assisted by recommendations and advisement of the Defense Systems Acquisition Review Council (DSARC)(7:4). For major acquisitions within the Air Force and as directed by the Secretary of Defense, the milestone decisions are made by the Secretary of the Air Force assisted by the recommendations and advisement of the Air Force Acquisition Review Council (AFSARC). The DSARC and AFSARC are the top level DOD and Air Force corporate bodies for weapon system

acquisition (9:2). The decision on whether to enter the next phase of acquisition is based on thresholds of cost, schedule, and performance.

Figure 1 depicts the major milestones and phases of the weapon system acquisition process. The acquisition process is initiated with a mission analysis. This analysis evaluates operational needs and the evolving technology base. At milestone 0, the decision is made on whether a mission need exists that warrants further study. If this need does exist, the decision is made to enter the Concept Exploration/Definition phase.

During Concept Exploration/Definition, a commitment is made to identify and explore alternative solutions to the needs identified in the mission analysis. The main characteristic of this phase is the solicitation for proposed solutions according to mission needs and not system characteristics. Therefore, establishment of a system acquisition program during this phase does not necessarily mean a new system will be acquired. At the completion of this phase, the Milestone I decision is made on whether to enter the Demonstration and Validation phase. This decision is based on the following considerations: program trade-offs; performance, cost, and schedule trade-offs; and affordability and life-cycle costs (9:3).

During Demonstration and Validation, the practicality and value of the alternative solution chosen during the previous phase is expanded and studied.

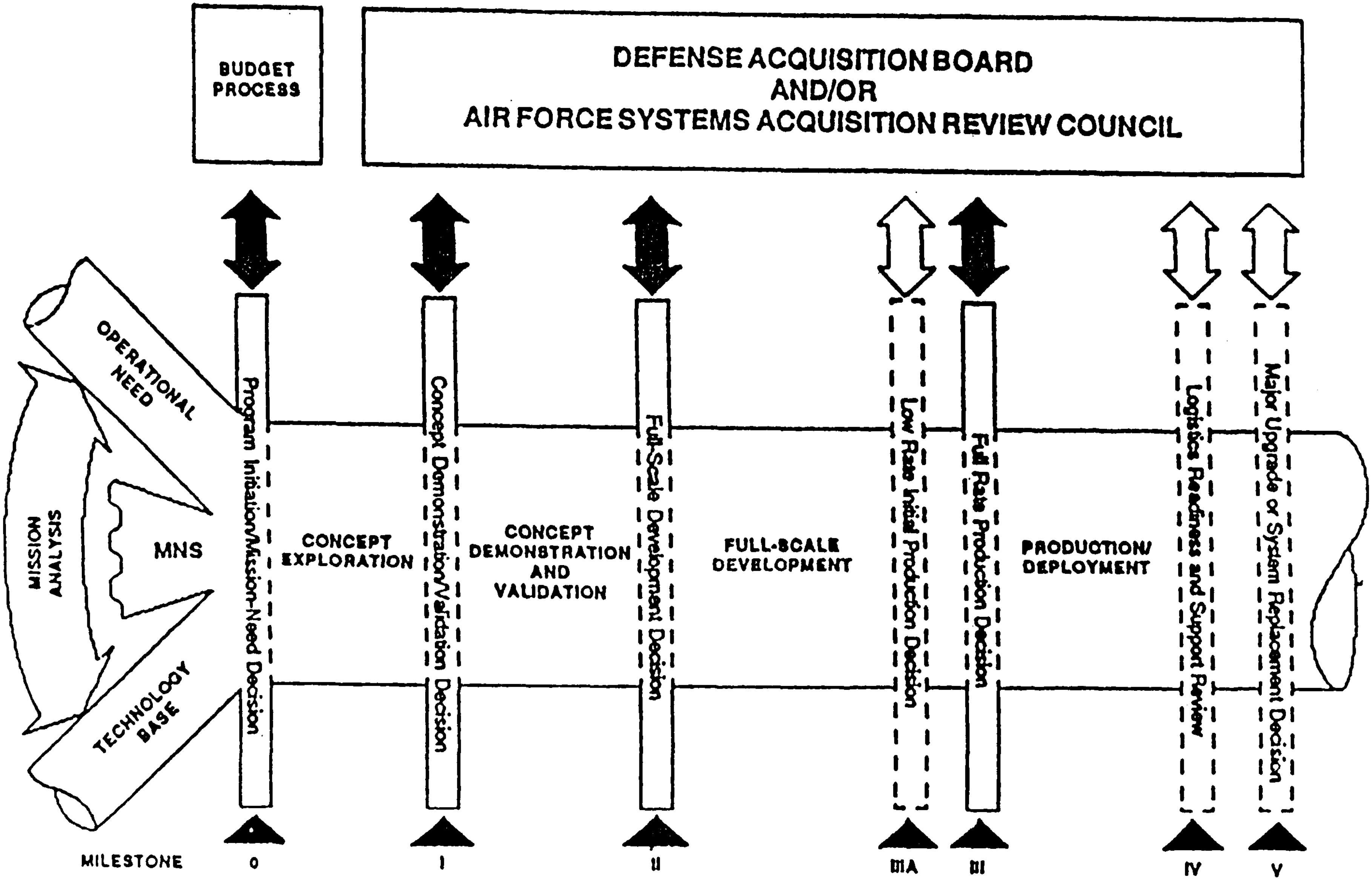

Figure 1. Weapon System Acquisition Cycle (8:3)

This study usually occurs through system prototyping, paper studies, and/or subsystem prototyping. The Milestone II decision occurs at the end of this phase and determines whether to enter the Full-Scale Development (FSD) phase, and when appropriate, low rate initial production (LRIP).

During FSD, the primary focus is on baselining the design of the weapon system and preparing the system and its producer to begin production. Included in this phase is the design and development of all required support equipment and documentation needed to produce and field the system. The Milestone III decision occurs at the end of this phase and determines whether to enter the Full-Rate Production and System Deployment phase (9:4).

During Full-Rate Production and System Deployment, the weapon system, training equipment, spares, and other support equipment are produced for operational use. Also during this phase, program management responsibility transfer (PMRT) occurs to coincide with deployment of the system and allow for field support. The Milestone IV decision occurs approximately 1-2 years after initial deployment to determine whether operational readiness and support objectives are achieved after several years of operational service (9:4).

Approximately 5-10 years after initial operational capability is achieved, the Operational Support phase occurs. The purpose of this phase is to determine whether the fielded system warrants a major upgrade or replacement.

The primary considerations during this phase are the capability of the system to continue to meet mission requirements, changes in threat, and assess new technology that offers significant increases in capability (9:4).

Transition From Development To Production

Transition of a weapon system from FSD into full-rate production is a broad and complex process. During this process, a weapon system is prepared for production. Emphasis is placed on finalizing the design of the system; establishing effective test measurements for the system's successful performance; and certifying manufacturing planning and processes to produce the system. The transition process is highly influenced by the extent of production planning early in the development phase.

Due to the broad and complex nature of the transition process, management of weapon systems from development through the production phase requires effective management and coordination across many functions of the program

The DOD policy regarding transition is stated in DOD Directive 4245.7, "Transition From Development To Production."

1. Acquisition programs shall be subjected to a rigorous, disciplined application of fundamental engineering principles, methods, and techniques in accordance with DOD 4245.7-M. Elements of program risk shall be identified and assessed throughout the acquisition cycle. The program's acquisition strategy shall feature provisions for eliminating or reducing these risks to acceptable levels. (2:2)

Transition Problems

Weapon system problems with performance, quality, and producibility frequently do not surface until the program transitions from FSD to production. Although the system may pass all of its milestone reviews, the weapon system still may not succeed due to technical reasons. These technical problems can be attributed to poor engineering designs. Poor designs result in higher rates of test failures and manufacturing problems that overwhelm production schedules and costs. These problems lead to the "hidden factory" syndrome of high redesign and rework rates. Also, field failures could result and hamper operational and training schedules.

The main contributor to transition risk and production problems is the emphasis on technical performance of a system during development at the expense of producibility, reliability, and maintainability. Since technical performance is the yardstick for success during FSD, the tendency is to overdesign to ensure adequate technical performance is met and ensure success during this phase. Consequently production planning is given a lesser priority than required during FSD.

Some of the major factors attributed to lack of early production planning in FSD and ultimately affect a successful transition are as follows:

1. Design Changes. Due to design refinements and correction of design deficiencies, the weapon system

baseline configuration is continuously changing. These design changes can be expensive to incorporate and cause scrapping and reordering of components and raw materials. In addition, design changes often require redesign of production processes and tooling (6:1).

2. Long Leadtimes. Material leadtimes can be affected by both design changes and poor vendor performance. Design changes often require ordering alternative parts and components to support these changes. Certain items such as forgings, precision castings, special alloys and electronic components have leadtimes ranging from 6 months up to 2 years (10:7). Therefore, design changes requiring material changes could have a significant impact on production costs and schedules. Poor vendor performance is a problem which is less manageable and is compounded by optimistic materials schedules that worsen the effect of late deliveries (10:7-8).

3. Poor Quality. Higher rates of hardware and test failures can be attributed to continuous design changes and lack of emphasis on producibility with respect to these changes (10:7-8).

4. Hidden Factory Syndrome. A result of any or all of the previously mentioned problems contributes to a large portion of the production facility, tooling, and personnel being consumed repairing, reworking, and retesting discrepant hardware or test failures. The net effect is a decrease in production capacity and adverse impacts on production costs and schedules (10:8).

The transition from development to production of new weapon systems is an important and complex process which should begin early in FSD and continue through production. Integrating and incorporating the design, test, and production planning early in FSD is vital to a smooth and successful transition. To support a successful transition, an adequately planned and funded acquisition plan which includes managing transition risks is essential.

Production Readiness Reviews

One of the most important reviews used by DOD to identify and manage production risks during transition is the PRR. The PRR concept evolved over a number of years in response to the growing need of determining whether a weapon system design and its contractor were ready to begin production. Beginning in 1977, DOD Directive 5000.34, "Defense Production Management," focused attention on minimizing transition risks by specifically assigning production management responsibilities. These responsibilities included ensuring that at the end of FSD, all factors relevant to production were considered and that the weapon system was ready for production. The basic criteria for entering production as outlined in this directive, was minimizing risks of breaching cost, schedule and performance thresholds. In 1979, DOD Instruction 5000.38, "Production Readiness Reviews," followed which further outlined the purpose, scope, and procedures for conducting PRRs.

DOD policy governing the implementation and management of PRRs requires that a PRR be conducted before production begins, including low rate initial production during FSD. The findings of the PRR will be provided to the highest level review body, either the DSARC or AFSARC as required to support the production decision (3:1).

PRR Objective

The purpose of the PRR is to determine if the weapon system design, production planning, and associated preparations for producing the system have progressed to a point where a production commitment can be made without incurring unacceptable cost, schedule or performance risks (3:1). Production readiness occurs when all engineering and manufacturing problems have been resolved or managed, and production planning has been reviewed in sufficient detail to minimize production risks (8:6).

PRR Process

A typical PRR examines the weapon system design for completeness and producibility. More specifically, the PRR evaluates the contractor's production planning, existing and planned facilities, tooling, manufacturing methods, material and manpower resources, production engineering, and overall production management (3:3). The PRR evaluation process consists of hands-on examinations of these functions and typically follows the flow illustrated in Figure 2.

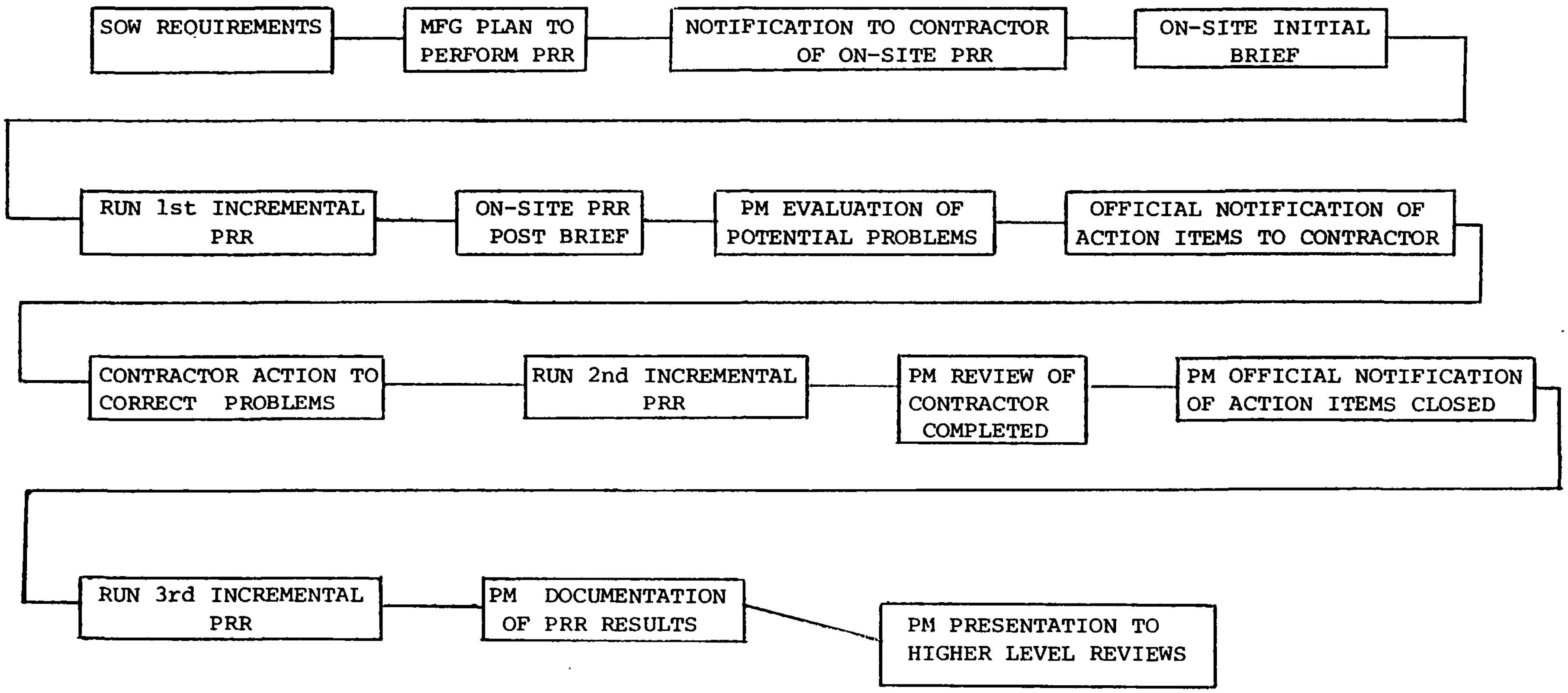

Figure 2. Typical PRR Process (8:98)

Also, included in this review were other functions which could have an effect on production costs and schedules.

The evaluation criteria or specific objectives varies between PRRs and is based on the complexity of the weapon system being produced; technical progress of the program; and the PRR team make-up. Once each function or element identified for review is evaluated, a determination is made as to the production risk of each element. Then a cumulative production risk is determined from all the reviewed functions combined. At the completion of the review, the PRR team director issues a report to the weapon system program manager which summarizes any risk potential, production deficiencies, and an overall assessment of transition activities. If the PRRs are conducted incrementally, these risks and concerns can be reduced or managed prior to the production decision. The program manager includes the final evaluation in his assessment of technical performance and transition risks to the required higher level review boards to support the production decision recommendation (3:1).

The initial PRR of a new weapon system should be conducted within 90 days of the Critical Design Review (CDR) and the final PRR is required at least 120 days prior to the Milestone III production decision (8:99).
When several PRRs are conducted, they should be incremental with an interval of at least 12 months. The number of PRRs to be conducted; the specific objectives of each PRR; and the time phasing of the PRRs is based on the length and

complexity of the program along with the performance of the contractor.

PRR teams consist of experts from the various functions of manufacturing management and program management. These experts are typically chosen from the System Program Office (SPO), Contract Administration Office (CAO), weapon system contractor, and other personnel as required (3:3). The PRR team is usually divided into panels based on functional areas to be reviewed (See Figure 3). These panels consist of personnel who review specific functional areas during the review. The number of panels varies between PRRs and appears to be dependent on the same criteria as the team size.

Obtaining contractor participation requires contractual coverage. This coverage is usually specified in the Statement of Work (SOW) in the FSD contract (11:11-17). Included in these requirements should be the number of PRRs required; extent of government and contractor participation; responsibility for subcontractors PRRs; and overall direction and purpose of the PRRs.

Defense Science Board Task Force Study

DSB Task Force Objective. Although PRRs were incorporated in the transition process, new weapon systems continue to encounter difficulties when beginning production. These continuing transition problems coupled with a rapidly increasing interest in upgrading the reliability and

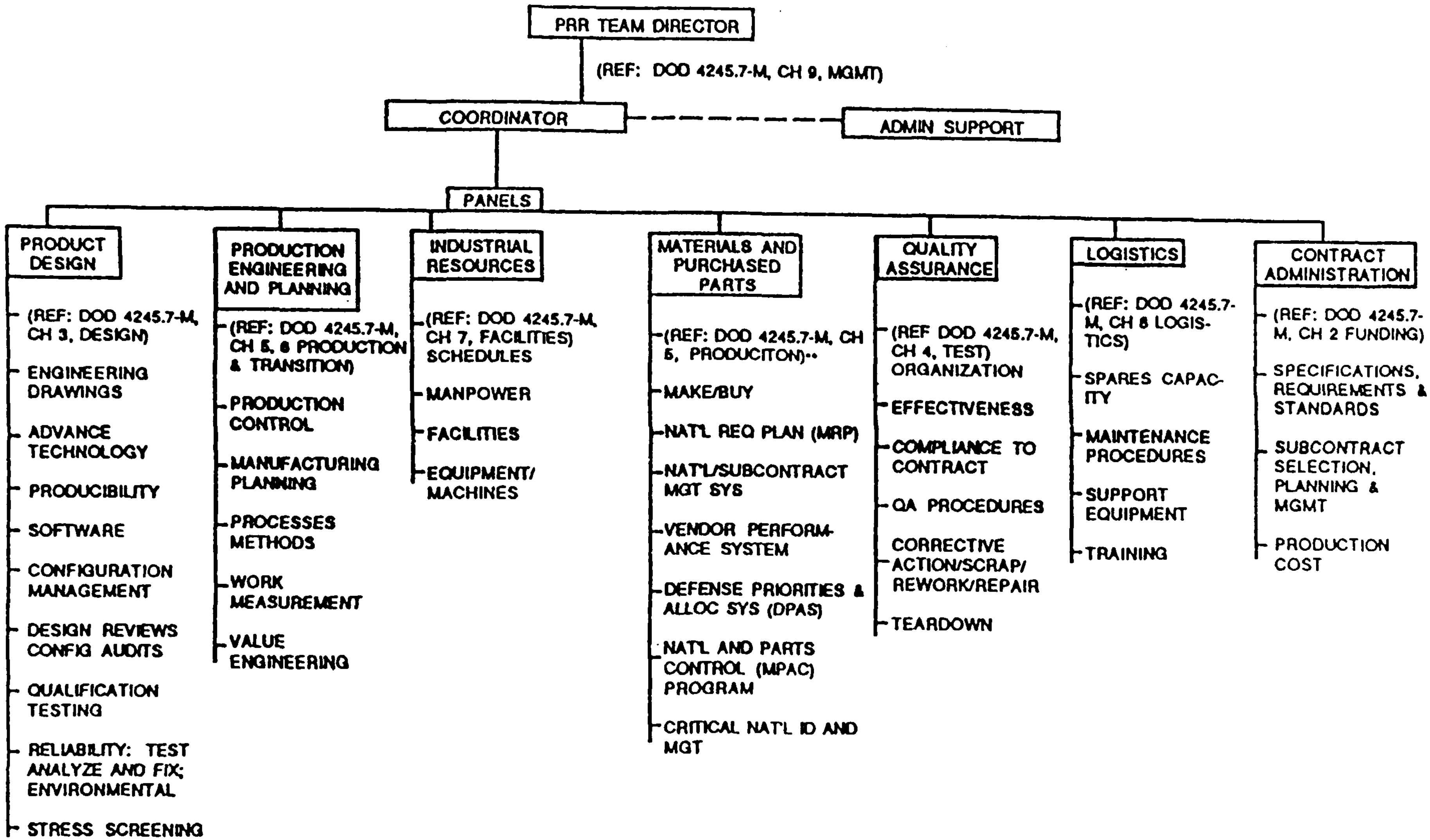

Figure 3. Typical PRR Team Structure (8:107)

maintainability of new weapon systems called for a review of the acquisition cycle. In response to these concerns, the Defense Science Board (DSB) Task Force on Transition of Weapon Systems From Development to Production was established in June of 1982. The purpose of the DSB Task Force was threefold. First, examine ways and methods to accelerate and improve the transition process; second, study both government and industry management of the transition process; and third, make recommendations relating to design, test, and production that will result in the timely delivery of quality products to the government (12:1). Included in this study was an evaluation of not only the technical aspects of the weapon system design and manufacturing processes, but also the funding and managerial aspects of the program (12:ix).

DSB Task Force Approach. The DSB Task Force consisted of top level experts from engineering, production, and overall program management from both government and industry. These individuals possessed extensive experience with DOD acquisitions and the transition process. The approach taken by the Task Force was the formation of five panels to evaluate and assess issues related to design, test, production, facilities, and management of the weapon system. Each panel was assigned specific issues and areas for detailed analysis. The focus of the study initially evolved around the fundamental principles and guidelines established through DOD policies and directives. However, after the

study started, the Task Force determined that some DOD policies and directives required change.

Upon completion of the study, each panel submitted a report of conclusions and recommendations to the Task Force Chairman who in turn, integrated and coordinated the conclusions and recommendations into the Task Force Report.

DSB Task Force Conclusions and Recommendations. The DSB Task Force concluded that the major causes of acquisition risk in the transition from development to production of weapon systems were more technical in nature than managerial. In addition, the Task Force concluded that these risks required the approach of designing the system with production in mind (4:1-3). Too often, weapon systems with inherent design deficiencies were allowed to transition into production with hopes that unproven manaufacturing technologies would improve the system's producibility. The DSB recommended approach to correct this situation is a disciplined engineering department that is interrelated with manufacturing engineering to factor producibility into the design early on in FSD (12:3).

Included in the DSB Task Force report were a set of templates , or checklists, that describe techniques for improving the acquisition process. The key to these templates is the fact that they treat the acquisition process as an industrial process involved with the design, test, and production of low risk weapon systems. Each template describes an area of risk and also managerial

methods for reducing or managing that risk. The templates were developed from lessons learned, analysis of a number of programs, and the technical expertise of the Task Force members (4:1-6).

General Accounting Office Study

GAO Study Objective. Continued problems of cost growth and late deliveries on new weapon systems entering production prompted a 1985 General Accounting Office (GAO) study entitled, "Why Some Weapon Systems Encounter Production Problems While Others Do Not: Six Case Studies."

The objective of the GAO study was to examine six weapon system acquisition programs and determine the causes of early production problems and outline corrective actions to preclude their occurence in future programs (6:i). In the GAO study, investigators concluded that inadequate production preparations during the development phase led to problems in production. In four of the six programs studied, production preparations were sporadic, underfunded, and conducted too late in FSD (6:ii). Additionally, PRRs were applied were quite differently in the six programs. In some cases, PRRs were used to assess production readiness and manage concerns and risks while in others they were used as a "gate to pass through" or "square to fill" before production (6:27). The programs that did not use PRRs as a tool for assessing and managing production readiness suffered significant cost and schedule problems.

GAO Study Recommendations. Based on the findings from their study, GAO investigators made the following recommendations to reduce the occurrence of problems early in the production phase.

1. Ensure that an adequate level of production preparations are made early and continuously through FSD.

2. Ensure that when funding or requirements changes affecting production are made in a program that the risks are assessed before making these changes.

3. Use PRRs as a tool in assessing and managing production readiness and risks. PRRs should begin early in FSD and be repeated at regular intervals until production begins (6:vii).

Air Force Systems Command

Mission. Air Force Systems Command (AFSC), headquartered at Andrews AFB, Md., is responsible for developing, acquiring, and delivering weapon systems the Air Force needs to meet its mission requirements. The command's emphasis is on delivering superior systems that are reliable, maintainable, and supportable. Through its six product divisions, AFSC strives to get capable weapon systems off the drawing board and into the field as quickly and cost effectively as possible. In addition, AFSC also handles the major aerospace responsibilities of DOD including research and development of satellites, boosters, space probes, and associated systems for NASA (13:1).

AFSC Product Divisions

Aeronautical Systems Division (ASD). Located at Wright-Patterson AFB, OH., ASD is the largest product division within AFSC. ASD is responsible for developing and acquiring aeronautical systems and related equipment for the Air Force. With a 1987 budget of $16.8 billion and a staff of more than 11,000 employees, some of the major programs under ASDs control include: the B1-B Strategic Bomber; B-2 Advanced Technology Bomber; Advanced Tactical Fighter; and the C-17 Airlifter. ASD's priorities include strengthening nuclear and conventional forces, expanding airlift capabilities, and modernizing the tactical air forces (14:1).

Munition Systems Division (MSD). Located at Eglin AFB, Fla., MSD is responsible for planning, researching, developing, and acquiring air armaments and related equipment. Included in MSD's mission area is a test wing equipped with test aircraft allowing MSD to manage new air armaments from "cradle to grave." Some major programs currently under MSD's control include: the Advanced Medium Range Air to Air Missile (AMRAAM); and the Sensor Fuzed Weapon(15:1).

Electronic Systems Division (ESD). Located at Hanscom AFB, MA., ESD is responsible for developing and acquiring command, control and communications systems for the Air Force. With an annual budget of over $4 billion, ESD works with operational forces to harness electronic technology for ensuring effective use of military personnel and weaponry (16:1). Some of the major programs currently under

the control of ESD include: the Airborne Warning and Control System (AWACS); and modernization of the North American Aerospace Defense Command Center.

Ballistic Systems Division (BSD). Located at Norton AFB, CA., BSD is responsible for developing and acquiring intercontinental ballistic missiles (ICBM). With a work-force of 950 military and civilian employees, BSD integrates the the activities of a number of major contractors who develope and build portions of missile systems. Major programs currently under the control of BSD include: the Peacekeeper Missile in Minuteman Silo; the Peacekeeper Missile in Railgarrison; and the Small ICBM (17:1).

Space Systems Division (SSD). Located at Los Angeles AFB, CA., SSD is responsible for research, development, acquisition, launch, and on-orbit command and control of military space systems. In addition, SSD is the focal point within DOD for plans and activities associated with the military use of the Space Shuttle. Some major programs currently under the control of SSD include: the Defense Satellite Communications System; the Navstar Global Positioning Satellite; and the Defense Meteorological Satellite Program (18:1).

Human Systems Division (HSD). Located at Brooks AFB, Tex., HSD is responsible for ensuring Air Force systems and operations are designed with human capabilities in mind. HSD focuses on integrating human operators into complex

systems, protecting crews in hazardous situations, and preserving the human environment (13:2).

These six major product divisions of AFSC comprise the major thrust of new weapon system acquisition for the Air Force. However, HSD was not considered for this research due its unique mission of research and development of human systems capabilities and low volume production efforts.

Research Methodology

To enable an in-depth and focused examination of actual PRR implementation and management practices, a case study analysis of ten current weapon system acquisition programs was conducted. The programs chosen provided the framework for the evaluation of programs ranging in size from relatively small to major DOD acquisitions. The programs chosen are listed in the following table.

Table I. Programs Selected for this Research

Weapon System	Product Division	Acq. Cost ($ in millions)
QF-106 Full-Scale Aerial Target	MSD	79
Improved Data Link Aircraft/Weapon Data Terminals	MSD	42 (FSD)
Sensor Fuzed Weapon Air Launched Missile	MSD	22 (FSD)
Advanced Medium Range Air to Air Missile (AMRAAM)	MSD	1,000 plus options
F100PW220/F110GE100 Jet Engines	ASD	300 plus options
Tacit Rainbow Missile	ASD	classified
Advanced Cruise Missile	ASD	classified
Low Altitude Navigation and Targeting Infrared at Night Pods (LANTIRN)	ASD	2,800
C-17A Transport Aircraft	ASD	36,000
B-2 Advanced Technology Bomber	ASD	65,000

Case Study Justification

The case study approach was chosen to attempt to resolve the research objective for this study. In this particular study, an attempt was made to determine how PRRs were actually implemented and managed on selected programs within AFSC. Because questions were posed with the focus on actual PRR applications rather than DOD regulations and directives; the case study was the preferred approach.

The results from this case study are generalizations based on the phenomenon studied and do not represent any specific sample or population.

The goal of this study was to expand and generalize the theories of PRR implementation and management which are actually used. The strength of this case study was its ability to deal with a wide variety of evidence which included PRR plans, PRR reports, PRR inbriefs/outbriefs, and informal interviews.

Case Study Design

The case study designed for this review consists of two main review elements (See Appendix A). These elements are documentation review and short personal interviews. Questions were generated which supported both a logical sequence of documentation review and provided the data to resolve the research objective. For the personal interview element, questions were generated that helped determine the meaningfulness or value to managers of the PRRs conducted on their programs. In addition, any recommendations for improvement of the PRR process was sought along with constructive criticisms. Although the interview element was highly opinionated, it provided actual managerial insight concerning PRR management.

Case Study Approach

In order to successfully answer the research objective, several different elements of actual PRR planning,

implementation, and management were reviewed. The following documents were reviewed as part of the documentation element of the research.

Contract Statement of Work (SOW). The SOW was reviewed for each program to determine what PRR requirements and planning were identified up front in the contract. In addition, the SOW was reviewed for specific government and contractor requirements for planning and preparations.

PRR Plan. The PRR plan for each of the ten programs was reviewed for actual pre-PRR planning. These plans reflected the number of PRRs planned for the program; time phasing and team sizes of PRRs; evaluation criteria; and government and contractor responsibilities.

PRR Inbriefs/Outbriefs. When available, the PRR inbriefs and outbriefs were reviewed for specific PRR objectives; team staffing and panel structure; evaluation criteria; and overall direction of specific PRRs.

PRR Reports. Specific PRR reports were reviewed for actual evaluation criteria; identification and management of any transition risks or production deficiencies; and overall managerial risk assessment.

Personal Interviews. Informal interviews were conducted with the manufacturing managers for all ten programs and with several program managers. The interviews provided the following management insights: philosophies concerning PRRs; value of PRRs; implementation and management strategies; and recommendations for improvement or change.

The purpose of the interviews was to supplement the findings from the documentation review. Any ambiguities or deviations from plans in implementation and management of PRRs were addressed through the interviews.

Scope of the Research

Due to resource constraints, the scope of this research was limited to selected programs within AFSC. More specifically, the programs were chosen from ASD at Wright-Patterson AFB, OH., and from MSD at Eglin AFB, FLA. These two product divisions were chosen for several reasons. First, they represent the two largest product divisions within AFSC and provided a greater database for gathering the required PRR data for analysis. Second, these two product divisions are more oriented towards production in terms of volume and funding. The remaining product divisions deal primarily in high cost, low volume products that would have narrowed the research.

The number of programs reviewed was also limited due to resource constraints. The ten programs were chosen based program status and availability of PRR data that provided the best basis for generalizations of PRR practices. In addition, the selected programs represent a continuum ranging from low cost and high volume to high cost and high volume weapon systems.

Chapter Summary

The transition from development to production of a weapon system is critical to its becoming a successful acquisition. During this transition, weapon system designs are prepared for production. One of the most important reviews used by DOD during the transition process is the PRR. However, even with the use of PRRs, new weapon systems continue to experience cost and schedule problems early in production. This was reflected in both the 1982 DSB Task Force study and the 1985 GAO study concerning transition and production problems. Both of these studies resulted in recommendations for improvement of the transition process and more specific use of PRRs.

The case study for this research was designed to identify the implementation and management practices of selected programs within AFSC. Included in this research was the determination if the recommendations from both government studies were being implemented.

III. Research Findings

This chapter presents the findings from the case study analysis described in the previous chapter. Data obtained from the informal interviews and documentation reviews were analyzed to provide the basis for the findings presented. The data and findings are presented in the form of responses along with specific details to the seven investigative questions for this research. In addition, several questions required comparison among product divisions, weapon system programs, and individual management approaches. These comparisons and generalizations are included in the responses to the applicable investigative questions.

Findings

Investigative Question 1. How are PRRs implemented and managed by the different weapon system programs among the product divisions of AFSC?

A series of questions were generated for the case study to identify and evaluate specific facts that respond to the investigative questions. More specifically, the following areas were addressed to provide this information: number of PRRs planned and implemented; duration of these PRRs; PRR team size and panel structure; evaluation criteria and risk assessment categories; risk management; and general emphasis or objective of these PRRs.

First, the number of PRRs that were planned and implemented varied among the ten programs. The average number of

PRRs planned per program was three with an average interval of 16 months. The number of PRRs conducted ranged from a low of one for an entire program to a high of six. The program which planned only one PRR was at the lower end on the continuum of program size, cost, and complexity while the two programs which planned six PRRs were at the higher end of this continuum. It was evident from this review that the number of PRRs planned varied in proportion to the size, cost, and complexity of the weapon system program. This is further reinforced by the fact that the size of the weapon system program office also varied in proportion to the program's size, cost, and complexity. Therefore, it follows that the smaller programs had fewer resources to commit to PRR planning, implementation, and management.

There was little difference between the average number of PRRs planned at ASD and those planned at MSD. ASD averaged 3-4 PRRs planned per program while MSD averaged 2-3 PRRs per program. This difference can probably be attributed to the fact that the programs reviewed at ASD were generally much larger than those at MSD.

Second, the duration of the PRRs that were conducted also varied among the ten programs. The average duration of all PRRs conducted was eight days with a range of three days as the shortest and 14 days as the longest. The programs which conducted three day PRRs were on the lower end of the continuum of program size, cost, and complexity while the programs which conducted 14 day PRRs were at the higher end.

Other factors which determined the duration of PRRs were the contractor's performance and timing of the PRRs in the FSD phase. In several cases, if the contractor was considered responsive and had proven good performance, the PRRs were shorter. Additionally, the PRRs conducted early in FSD were usually shorter than those conducted immediately prior to production.

There was a difference of only one day in the average duration of PRRs between ASD and MSD. The duration of the PRR was the actual scheduled review time and did not include weekends or travel time. The average duration of PRRs at MSD was approximately seven days while the average duration for ASD was approximately six days. This difference in duration can be attributed to the fact that more PRRs are conducted per program at ASD than at MSD resulting in more details or areas to cover per PRR at MSD. This fact is further reinforced by the range of PRR durations at both product divisions being equal and varying in proportion to the same program size, cost, and complexity criteria.

Third, the sizes of the PRR teams also varied among the ten programs. In addition, PRR team sizes also varied between the different reviews conducted on the same program. The average team size of all PRRs conducted was 36 people with a range from a low of 15 people to a high of 70 people. However, the three largest programs had teams of 60 or more people and inflated the average for all ten programs. By disregarding the three largest programs, the average team

size was 27 people with a range of 15 people for a low and 40 people for a high.

There was no clear factor identifiable which determined the sizes of PRR teams. As expected, the three largest programs in fact had the largest PRR teams. However, the size of PRR teams for the remaining programs were not in proportion to program size, cost, and complexity. This could be attributed to other factors that might influence team size such as PRR duration and frequency.

There was little variation in the sizes of PRR teams at ASD and those at MSD although ASD's programs were much larger. Actually, PRRs at MSD averaged two more people than those at ASD. This follows the generalization that PRR team size is less influenced by program size, cost, and complexity but rather by PRR frequency and duration.

Fourth, the average number of review panels per PRR for all ten programs was six with a range of three panels for a low to eight panels for a high. Only one program used three panels while the rest used between five and eight panels. The number of review panels did not vary in proportion to program size or cost. In addition, there was no panel variation between the different PRRs conducted on the same program indicating the timing or frequency of PRRs was not an influence on the number of panels used. It was evident that the primary factor influencing the number of review panels was the complexity of the weapon system.

The most frequently used panels among the ten programs along with their frequency are as follows: quality assurance (10); material management (8); manufacturing (8); engineering (7); and manufacturing engineering (6). Any additional panels were utilized based on specific program needs and weapon system complexity.

There was no difference in the average number of panels used or the frequency of specific panels between the programs of ASD and those of MSD. This reinforces the generalization that the number of panels per PRR were more influenced by program complexity than by program size and cost.

Evaluation criteria and risk management techniques among the ten programs will be addressed in a later investigative question.

Investigative Question 2. Is there adequate guidance and direction provided in DOD and Air Force Directives and Regulations for implementing and managing PRRs?

Both DOD Instruction 5000.38, "Production Readiness Reviews," and Air Force Regulation 84-2, "Production Readiness Reviews," were referenced in the PRR Plans for all ten programs. Manufacturing Directors and Manufacturing Officers from all ten programs generally felt these regulations provided adequate direction for the basic planning and preparation activities. However, actual PRR implementation and management rested primarily with the experience and expertise of the manufacturing personnel involved with the PRR. This generalization is reinforced by

the different implementation and management strategies employed by the ten programs which went well beyond the direction provided in the regulations.

Most programs utilized the regulations for basic PRR planning and ensuring that the program met both DOD and Air Force requirements. In addition to the basic requirements, PRRs were tailored to meet the program's needs. These needs were primarily based on program size, cost, and complexity. The tailoring of PRRs to meet program needs was basically accomplished through the expertise and experience of the program's manufacturing management personnel.

There was no identifiable difference between programs at ASD or MSD regarding the use of DOD and Air Force Directives in planning and implementing PRRs.

Investigative Question 3. What criteria, policies, and procedures are currently used by the different program offices in evaluating and assessing the readiness of their weapon system and contractor to begin production?

There were basically three different approaches used by the ten programs for evaluating and assessing production readiness and associated risks. The three approaches used are described in the following paragraphs.

First, the two largest programs implemented nearly all of the transition templates from DOD Manual 4245.7 in their PRR Plans. The extensive template approach provided the guidelines for which the entire PRR was planned in an attempt to ensure complete reviews of these large, complex programs. From these templates, standards were

developed which were based on the requirements of the contract SOW and good business practices. (See Appendix B for a sample of standards developed by the C-17 Program Office) These standards provided the team members with the following review data: a description of the PRR factor being reviewed; a reference to any applicable MIL-STD or good business practice; a set of subfactors to evaluate; and a list of data required for review to adequately assess the PRR factor. In addition, each team member was given a copy of DOD Manual 4245.7 to use as a hand guide.

Risk assessment categories were also taken directly from DOD Manual 4245.7 to determine associated production risks from the PRR findings. These risk categories were as follows: "high" for risks likely to cause major impacts to cost, schedule, or performance; "medium" for risks with potential impacts; and "low" for risks with low potential impacts.

Production readiness concerns and risks were managed through the use of forms entitled Requests For Action (RFA). An RFA identifies concerns or problems, suggests possible solutions, and requires the contractor to provide a corrective action plan with an accompanying schedule. The RFAs were then formally tracked at subsequent reviews. The second approach had three programs tailoring the use of the transition templates more to meet specific program needs. Specific evaluation areas were identified and then evaluation

criteria or questions were developed by team members utilizing applicable templates. These criteria or questions generally followed the guidelines outlined in the templates. However, this approach relied more on team member experience and expertise. In addition, each team member was given a copy of DOD Manual 4245.7 to use as a hand guide.

Risk assessment categories for these programs were taken from AFSC Regulation 84-2. The risk categories for impacts to cost, schedule, and performance are as follows: "non-recoverable" for risks which will cause definite substantial impact; "high" for risks where adverse impact is likely; "moderate" for risks where management attention could prevent impacts; and "low" when there is no evidence of any risk.

Production readiness risks or concerns were managed for all three programs with the use of RFAs. Two programs had formal tracking and statusing procedures in place for managing these RFAs. The third program did not have a formal method for managing RFAs but rather left the responsibility for correction totally up to the contractor.

The third approach combines all the approaches taken by the remaining programs. All five remaining programs used evaluation criteria that was a compilation of previous PRR Plans, lessons learned, and team member expertise. In most cases, questions were generated by the team members and approved by the team director. This approach led to a more tailored PRR based on progress or status of the program.

Although the symbols and descriptions were slightly different, it was apparent that all five programs used risk categories based on AFSC Regulation 84-2.

Production readiness risks or concerns were managed by three of the five programs with the use of RFAs. The primary tracking and statusing method was follow-on incremental reviews. The remaining two programs did not have formal management procedures for risks or concerns. Rather, this responsibility was left entirely up to the contractor. In addition, incremental PRRs were used to verify corrective actions.

<u>Investigative Question 4</u>. Do these criteria, policies, and procedures reflect the recommendations of both the 1985 GAO study and the 1982 DSB study regarding transition into production?

The general intent of both studies was addressed for incorporation into actual PRR implementation and management practices of all ten programs.

First, the primary thrust or focus of the 1982 DSB Task Force study was directed towards examining ways and methods that more clearly define and accelerate the transition from development to production of weapon systems. In response to this task, a matrix of the most critical events in the design, test, and production elements of the industrial process was generated. These elements were used to develop a set of templates that describe techniques for improving the acquisition process and reducing production risks. These templates were recommended by the DSB Task

Force to be utilized as a tool for transitioning weapon systems from FSD into production.

Five of the ten programs made extensive use of these templates in planning, implementing, and managing PRRs. The templates were tailored to meet program needs and were incorporated in the program's PRR Plans. In addition, all five programs provided copies of DOD Manual 4245.7 to PRR team members prior to each PRR.

The five remaining programs did not use templates but rather developed their own evaluation criteria and risk assessment strategies. Two of these programs did not incorporate the recommendations or intent of the DSB Task Force study. Instead of identifying and minimizing technical risks during transition, a minimal number of PRRs were conducted which took a "snapshot" in time of program progress. The other three programs met the intent of the study through the use of detailed PRR plans and evaluation criteria which paralleled the template approach.

Second, the emphasis of the 1985 GAO study was to determine why some weapon systems encounter production problems while others do not. The primary recommendations from the GAO study that pertain to this research were the employment of PRRs as a tool for managing production preparations to progressively reduce production risks, beginning early and repeating them at intervals during FSD.

Seven of the ten programs had detailed plans for multiple PRRs to be conducted incrementally. Each of these

seven programs planned for an average of four PRRs with an average interval of 16 months. The three remaining programs planned for an average 1-2 PRRs each with no consistent interval. It's apparent that the seven programs with the multiple incremental PRRs meet the intent of the GAO recommendation for incremental reviews.

However, the average time interval from FSD start-up to the initial PRR for seven programs was 31 months. The interval for the remaining three programs was not available. Although the time interval to the initial PRR is dependent on the level or complexity of weapon system development, it does not appear that the intent of the GAO recommendation for using PRRs early in FSD is being met.

Investigative Question 5. How are the transition templates from DOD Manual 4245.7, "Transition From Development To Production," applied to PRR implementation and management by the programs which used them?

The five programs which used these templates had two approaches. First, as mentioned previously, the two largest programs made extensive use of the templates with a detailed PRR Plan incorporating a majority of the templates. These programs were so large in scope and complexity that nearly all of the templates were applicable. The approach taken by the remaining three programs was to tailor the use of the templates to meet specific program needs. These programs were much smaller in scope and complexity and thus, in the judgement of the key managers, required a more limited use of templates.

There were no specific templates identified which were favored by any PRR teams. In addition to contractor performance, the primary influences on the templates used were program size, cost, and complexity.

Although five programs made extensive use of the templates, these programs were provided little guidance or direction. The Manufacturing Directors for three of these programs were introduced to the use of templates at a three day Navy conference. The remaining two Manufacturing Directors incorporated the use of these templates at the suggestion of HQ AFSC. All five Manufacturing Directors stated they would continue to use the templates on future reviews.

Investigative Question 6. What contractual requirements were placed on the contractor to plan for and support PRRs?

Very few requirements were outlined in the contract SOW for each of the ten programs. The basic reference in each program's SOW called for the contractors to participate in PRRs. Several of the contracts referenced a requirement for the contractor to perform PRRs at the major subcontractors. There was only one program which made reference to more specific planning criteria and more detailed contractor support requirements. However, these criteria were still lacking enough detail for contractual enforcement.

Investigative Question 7. Of what perceived value are PRRs to program managers in transitioning their programs into production?

Only five program managers were available for interview on this subject. Three of these program managers felt the PRRs were adequately conducted and provided the required information to help transition their programs. Of the remaining two program managers, one felt a need for additional data while the other did not like the PRR concept and felt it was inadequate.

The role the PRRs played in helping program managers transition their programs into production parallels the adequacy breakdown mentioned above. Three program managers felt the PRRs played a very important role in managing their programs. This was reinforced by the fact that these program managers actively planned and participated in their PRRs. In addition, the Manufacturing Directors for these programs felt their program managers were totally committed to the PRR process. The remaining two program managers were unsure of the role of PRRs in their programs and were not committed to the PRR process. The Manufacturing Directors for these two programs had total responsibility for planning and implementing their PRRs.

Summary

This chapter detailed the findings of the study in the form of responses to the investigative questions. These findings were based both on a detailed review of PRR documentation and informal interviews of program managers and manufacturing directors. The next and final chapter

presents conclusions and recommendations with regard to actual PRR implementation and management practices.

IV. Conclusions and Recommendations

This chapter presents the conclusions and associated recommendations of this research. The conclusions drawn are based on data from the literature review and case study findings of actual PRR implementation. The recommendations are based on one or more of the following: program specific PRR practices that improved PRR management; changes to current PRR practices that could further improve PRR management; and suggested changes taken from the interviews of program managers and manufacturing managers.

Conclusions

The primary objective of this research was to determine how PRRs are planned and implemented during the transition from development to production of selected weapon systems within AFSC. Based on the findings presented in Chapter III, several conclusions were drawn.

First, it was evident that each of the ten programs followed the basic DOD and Air Force requirements for conducting PRRs. All ten programs conducted at least one PRR prior to the milestone III decision. However, both the DOD and Air Force Directives lacked sufficient guidance for implementing and managing PRRs. There were no criteria available to help program offices determine the most beneficial approach to help transition their programs into production. Once the basic requirements for planning PRRs

were met, actual PRR implementation and management relied heavily upon previous experience and lessons learned, when available. In many cases, PRR plans were taken from other programs and used while a few programs extensively planned their own PRRs. This approach, or policy, of leaving implementation and management up to the individual program offices has both positive and negative implications.

A positive aspect of this approach was that program offices were allowed to tailor the whole PRR process to meet their specific program needs. In most cases, the PRR process was tailored by developing program specific evaluation criteria; adjusting the number and frequency of PRRs conducted; and adjusting PRR team size. This approach allowed more flexibility in managing weapon system programs through the transition process. However, this approach relied heavily on PRR team member expertise and experience.

Conversely a negative aspect was that the smaller programs did not have the resources to extensively plan and implement PRRs. Without the expertise and experience, several smaller programs were forced not to tailor the PRR process to meet program needs but rather just meet the basic PRR planning requirements identified in DOD and Air Force Directives. Two programs in particular, did not have a plan for managing areas of concern or deficiencies identified by the PRR team. In these two cases, without specific directions or guidance, the PRR process was not adequately implemented and managed. With this approach, the

opportunity for a program to enter into production without adequate preparation is increased and could increase the likelihood of cost overruns and schedule delays.

All ten programs identified basic and general requirements and objectives in the contract statement of work (SOW). Although the SOW is the primary vehicle for the government to bind the contractor to his responsibility, none of the programs identified specific PRR objectives, requirements, and schedules. The basic requirements in the SOWs were to conduct PRRs on the prime contractors and the requirement for the prime contractors to conduct PRRs on the major subcontractors. The specific requirements for contractor support and preparation for PRRs was levied informally. This approach was generally successful. However, two programs having non-responsive contractors had ineffective management of PRR areas of concern and deficiencies. In addition, the contractors were ill prepared for the initial PRRs on their programs.

The PRR Plans identified program specific PRR implementation and management strategies. Usually included in the PRR Plan were PRR objectives, evaluation criteria, team structure, and review schedules. All ten programs had detailed PRR Plans. However, two programs did not have evaluation criteria included in their PRR Plans. Instead, team members generated questions to include in the PRR and submitted them to the team leaders prior to the start of each PRR. Most programs did not change the PRR Plan between

incremental reviews. The manufacturing directors were responsible for development and management of PRR Plans for their programs.

The number of PRRs varied in proportion to the size, cost, and complexity of the weapon system program. However, excluding the two larger programs, the duration of PRRs appeared to vary inversely to the number of PRRs conducted. The smaller, less complex programs conducted fewer PRRs with longer durations while the larger programs conducted more PRRs with shorter durations.

There was no clear factor identified during the review that influenced the size of the PRR. Some of the smaller programs had larger PRR teams than much larger programs. It appears that PRR team size was a variable that may have been used to compensate for other factors affecting PRRs such as duration and frequency. Smaller programs may have enlisted larger teams to help ensure all areas of production readiness were reviewed in a lesser number of reviews.

The PRR panel structure used by each program was not influenced by program size or cost. Rather, the primary factor influencing panel structure was weapon system complexity. The more complex systems required more review panels while the less complex systems required fewer.

PRR management was reviewed for risk assessment and risk management techniques. All ten programs had risk assessment categories identified in their PRR Plans. However, the risk assessment process was very subjective in

nature and not quantifiable. Although the categories was identified, actual classification of findings or concerns were essentially left to the PRR Panel Chiefs or Team Director. The five programs which used the DOD Manual 4245.7 transition templates had more specific criteria to assist in classifying findings. However, the process still relied on subjective decisions from the PRR team leaders.

Risk management was generally accomplished with the use of requests for action and follow-up reviews. Seven of the programs used this method of requesting corrective actions from contractors for any concerns or deficiencies. These corrective actions or plans were then tracked and monitored during follow-up reviews. The three remaining programs had no formal risk management process but rather left total responsibility to the contractor for corrective actions.

A second research objective was to determine if the recommendations from the 1985 GAO study (Why Some Programs Encounter Production Problems While Others Do Not) were implemented. The primary recommendations as they pertain to this research were to ensure that an adequate level of production preparations were conducted early and continuously throughout FSD. In addition, PRRs should be used as a tool for managing these production preparations to progressively reduce production risks, beginning early and repeating them at specified intervals during FSD.

These recommendations were not fully implemented on any of the ten programs. Seven programs planned for incremental PRRs throughout FSD. However, the average time lapse from the beginning of FSD to the initial PRR was 31 months. The remaining three programs did not plan incremental PRRs but rather planned for a minimum number of reviews closer to the Milestone III decision.

The final research objective was to review how the transition templates from the 1982 DSB Task Force study on transition were being applied in the PRR process. Five programs actually used the transition templates for PRR planning and implementation. There were two basic approaches used to incorporate the templates into the PRR Plan.

One approach that was taken by two larger programs was the implementation of nearly all of the templates. This extensive approach provided the guidelines for which the entire PRR process was planned to ensure a complete review of these complex programs. Included in this approach were the risk assessment criteria taken directly from the templates.

The second approach involved three programs that tailored the use of the transition templates to meet specific program needs. These programs were smaller and did not require the all encompassing template approach. Specific evaluation areas were identified and then evaluation criteria or questions were developed by team members

utilizing applicable templates. These questions generally followed the guidelines outlined by the templates. However, this approach relied more heavily on team member expertise and experience.

Recommendations

In response to the conclusions listed above, and in an attempt to improve the PRR process, a number of recommendations are presented below. These recommendations also reflect suggestions taken from the interviews of program managers and manufacturing managers.

Recommendation Number One. The DOD and Air Force Directives and Regulations governing PRR implementation and management should be revised to provide more guidance and direction for planning PRRs.

General guidelines including proven PRR techniques should be provided that correlate to program size, cost, and complexity. This research reflects the significance of this criteria on the PRR process. The additional guidance and directions could help program offices better design and tailor a PRR process to meet specific program needs. The PRR is probably as important to the production phase as the PDR and CDR are to the FSD phase. Perhaps developing a MIL-STD for PRRs similar to MIL-STD 1521B for design reviews could provide the necessary PRR planning guidance. With this guidance, smaller programs with limited manufacturing resources might be compelled to better plan PRRs to meet

their program needs rather than simply meeting basic DOD requirements.

Recommendation Number Two. PRR objectives and requirements should be specified in greater detail in the contract SOW. The SOW is the primary vehicle the government uses to levy contractual requirements and support for PRRs on the contractor. However, there were few specific requirements identified in the SOWs for any of the programs reviewed. The SOW should specify the purpose and goals of the PRRs. In addition, a tentative schedule should be included to allow both the government and contractor to adequately prepare for these reviews. Also, specific requirements for preparation and support of PRRs is needed to ensure that contractors understand their roles and responsibilities. Citing regulatory guidance and identifying review techniques could also improve contractor preparations.

Recommendation Number Three. Provide more training and preparation for PRR team members prior to their respective PRRs. Several program managers and manufacturing managers voiced the need for more experienced personnel for PRRs. Due to the shortage of experienced manufacturing personnel, training existing personnel and improving PRR preparations are the best approach to fulfill this recommendation. In addition, better use of CAS personnel administering the program in the field coul provide

insights into production deficiencies that might not otherwise be detected during a short review.

Recommendation Number Four. Program offices should conduct joint government and contractor PRR planning meetings at least 60 days prior to each PRR. This joint meeting could provide the contractor a better direction or focus for preparing for specific PRRs. The object of these PRRs is to prepare the contractor and the weapon system for production. By providing the contractor specific PRR objectives and evaluation criteria, preparation for the PRR and, more importantly, the transition to production should be improved. In addition, specific roles and responsibilities for both the government and the contractor can be reviewed for clarification or change.

Recommendation for Further Research

This research revealed several different approaches to planning, implementing, and managing PRRs. These different approaches reflected a multitude of techniques based primarily on program size, cost, and complexity. In addition, the level of experience and expertise of manufacturing personnel also contributed to the particular approaches used.

Further research could help answer the following questions in determining the best PRR approaches. How successful will these weapon system programs be when they enter the production phase? Which approach for planning, implementing, and managing PRRs best prepared programs for

production? Did the programs which used the transition templates fare well in production? Was the use of the transition templates a significant contributor to program success?

These questions could be answered by conducting a follow-on study in approximately 24-36 months. These ten programs will be well into production and would provide a basis for correlating their success with the approach taken for production preparations. With this further study, recommendations for continued PRR improvement could be made.

Appendix A: Case Study Questions

Program Background

1. What is the weapon system being procured? (Contract)

2. Which product division is responsible for managing this acquisition?

3. When did FSD begin? (Contract)

4. What was the dollar value of the FSD contract?

5. When was the production decision made? (Program Manager, Contract)

6. What is the dollar value of the production contract? (Contract)

7. What is the primary deliverable end item and quantity to be produced? (Contract)

PRR Requirements in Contract Statement of Work

1. What is the dollar amount identified in the contract for PRR planning and implementation? (Contract)

2. What are the PRR requirements identified in the SOW?

3. When is PRR planning to begin? (SOW)

4. How many PRRs were planned? (SOW, PRR Plan)

5. What contractor involvement in PRRs is identified in the SOW?

6. What additional government or contractor requirements are identified in the SOW to support PRR planning and implementation?

PRR Plan

1. How many PRRs were conducted? (PRR Plan, PRR Report)

2. When was the first PRR conducted with respect to the beginning of FSD? (PRR Plan, Contract)

3. If more than one PRR was conducted, were they conducted incrementally? (PRR Plan)

4. When was the last PRR conducted with respect to the production decision? (PRR Plan)

5. What were the stated objectives of the PRRs? (PRR Plan, In-briefs, Policy)

6. What aws the size of each PRR team? (PRR Plan, In-brief)

7. What was the duration of each PRR? (PRR Plan, PRR Report)

8. What type of CAS support was provided? (PRR Report)

9. What type of contractor support was provided? (PRR Report)

10. Were templates from DOD Manual 4245.7 used in evaluating production readiness and risks? (PRR Plan, In-brief)

11. If these templates were not used, what evaluation criteria was used in determining production readiness and risk assessments? (PRR Plan, In-brief)

12. If DOD Manual 4245.7 was used, which templates were used in the evaluation? (PRR Plan, In-brief)

13. How were production readiness concerns or risks managed prior to start of production? (PRR Plan, PRR Report)

Program Manager Interview

1. Did the PRR process and report provide you with adequate production readiness and risk data to assist you in managing the transition of your program into production?

2. What additional production readiness data, if any, did you need to manage your program?

3. Did the PRR process play a role in the management of your program's transition into production?

4. Are you familiar with DOD Manual 4245.7 "Transition From Development into production?

5. What changes would you suggest to improve the PRR process?

Manufacturing Manager Interview

1. Do you feel there is a commitment from the program office for planning and implementing PRRs?

2. Do you feel that PRRs are adequately planned and implemented for your program?

3. Do you feel that the contractor has adequately prepared for and supported PRRs?

4. What changes in the PRR process would you recommend?

5. Are you familiar with DOD Manual 4245.7 "Transition From Development to Production?"

6. Have you ever used DOD Manual 4245.7 as a guide for PRRs? If so, would you use this approach again? (i.e. are the templates valuable?)

7. If you have used DOD Manual 4245.7 during PRRs, where did you get direction or guidance for their use?

8. Which templates did you use?

9. Are there any templates which you feel significantly aided in evaluating and assessing the readiness of the program for production?

Appendix B: Sample Evaluation Standards

Panel 1.0 Manufacturing

Factor 1.1 Manufacturing Management and Support

Subfactor 1.1.4 Manufacturing Management Systems

Reference: SOW 1062JAA, MIL-STD-1528

Description: This subfactor involves the assessment of existing/planned system for managing the manufacturing effort. Specific topics to be evaluated are description of management systems, systems utilization, effects of concurrency, and management systems interaction and relationship with other disciplines. This subfactor also assesses the contractor's total manufacturing organization and how it integrates with other functional disciplines. Specific topics to be highlighted are manufacturing integration, organization and concurrency.

The subfactor is satisfied when the following standards are adequately met:

1. The contractor shall have and use a manufacturing management system that implements MIL-STD-1528 (SOW 1062JAA). This is verified by the following:

   a. AF approved Manufacturing Plan

   b. Adequate and complete procedures

   c. Procedures that are current and controlled

   d. Compliance with procedures by intended users

2. Clear definition of authority and responsibilities of the organizations and personnel charged with execution of the manufacturing management system.

3. Internal review process to monitor manufacturing management system effectiveness.

4. A complete, detailed manufacturing organization chart with the lines of authority and responsibilities clearly defined.

5. Clear definition of vertical and horizontal lines of communication and interfaces with other (Quality, Engineering, Material, etc.).

Panel 2.0 Engineering

Factor 2.2 Producibility of Design

Description: This factor examines the contractor's progress in implementing their plans and procedures in terms of ensuring that manufacturing engineering has continuing input to design engineering during product design and documentation activities.

This factor is satisfied when the following standards are adequately met:

1. The contractor follows their objectives, policies, and procedures to enhance producibility based on past experience, accepted commercial practices, and Air Force/ lessons learned.

2. The defined interface relationships between Manufacturing Producibility (MPO) and Engineering Producibility (EPO) organizations is producing verifiable exchanges and incorporation of changes.

3. The contractor is abiding by the policies and procedures to standardize the number and types of materials, processes, and parts and is able to demonstrate progress in this area.

4. The contractor has resolved design approach conflicts between manufacturing and product design functions.

5. The contractor can provide examples of producibility concerns being addressed by design engineering and other functions such as logistics and manufacturing.

6. The contractor can provide any changes to policies, procedures, or plans since the last PRR and the impact of these changes to the producibility function.

7. The contractor has control of subcontractor producibility efforts. Appropriate requirements are incorporated in subcontracts and are being monitored.

8. Producibility studies have been conducted and are utilized by design/manufacturing engineering. These studies include interfaces with other areas such as Logistics and Manufacturing.

9. Producibility engineering is reviewing all drawings in accordance with established procedures and in a timely manner. The drawing review cycle allows time for producibility review.

10. Training in producibility is conducted on a continuing basis for all engineering disciplines.

11. Employee suggestion/shop feedback is actively pursued and result implemented where appropriate.

12. The producibility function is staffed to adequately handle present workloads. A manloading plan is in effect to cover future needs.

Panel 4.0 Quality Assurance

Factor 4.1 Quality Program

Description: This factor evaluates the contractors plans, procedures and documentation used to conduct an effective, economical and integrated quality assurance program that includes provisions for assuring quality in design, development, fabrication, processing, assembly, test and preparation for shipment.

Subfactor 4.1.1 Organization and Planning

Description: This subfactor evaluates the contractor's management of the quality program.

This subfactor is satisfied when the following standards are adequately met:

1. The contractor's quality program follows the Quality Program Plan (P410). Identifies how the Quality Program Plan is utilized/and maintained by the contractor.

2. Each of the quality requirements within the SOW is specifically addressed and adequately covered by the Quality Program. (MIL-Q-9858A, 3.2,

3. Personnel performing quality functions have been identified and have well defined responsibility, authority, and organizational freedom to identify and solve quality problems. (MIL-Q-9858A, 3.1)

4. The quality program provides for analysis and use of records as a basis for management action. Adequate evidence exists to show that management

action considers quality program inputs. Quality reports are furnished to management for information and action. (MIL-Q-9858A, 3.4, DAC CP 10.021, Regulation 9)

5. The contractor identifies, maintains and uses specific cost data to identify the cost of prevention, detection and correction of nonconforming supplies. The contractor maintains surveillance of program quality costs. (MIL-Q-9858A, 3.6,

6. The contractor is maintaining a Quality Improvement Program compatible with the ASD Quality Improvement Strategy. The contractor's program has a baseline against which tangible improvement can be shown.

PANEL 7.0 TEST/SAFETY

FACTOR 7.2 SAFETY

SUBFACTOR 7.2.3 System Safety Program

Description: This subfactor evaluates the System Safety Program to ensure the contractor has developed and implemented adequate, aggressive measures, in accordance with the contract, to identify, evaluate and eliminate or control hazards throughout the design of the system.

The subfactor is satisfied when the following standards are met:

1. The contractor has developed, and updated as required, an adequate System Safety Program Plan which describes in detail the efforts to be implemented to comply with the contractual system safety requirements.

2. The contractor is adhering to the schedule of events contained in the System Safety Program Plan.

3. The contractor presents adequate evidence to indicate that the System Safety Office interfaces with each of the subsystem engineering divisions to ensure an integrated safety effort is accomplished.

4. The contractor shows they are conducting rigorous hazard analyses in accordance with the contract, to identify, evaluate and eliminate or control system hazards.

5. The contractor has developed and implemented a hazard tracking system that ensures all category I and II hazards, and those with an RHI of 8 or greater, are monitored to ensure corrective actions are

incorporated into the design. The contractor must also show this tracking system is accurate and up-to-date.

6. The contractor shows that no identified hazard remains with an RHI of 12 or greater.

7. The contractor demonstrates that they are making maximum use of the LSA data base as it becomes available.

8. The contractor shows active interfacing with the test engineers to ensure the appropriate safety requirements are incorporated into the plans, procedures, work efforts and results for all testing activities.

9. The contractor demonstrates that thorough system safety programs are being conducted by their subcontractors and suppliers.

10. The contractor is making active contact with the support equipment engineers to influence the system safety and occupational safety of newly developed or significantly modified support equipment.

PANEL 8.0 FINANCIAL MANAGEMENT

FACTOR 8.1 BUDGET EXECUTION

SUBFACTOR 8.1.2 Contract Funds Status

Description: This subfactor addresses the requirements of the Contract Funds Status Report (CFSR) prepared in compliance with the Contract Data Requirements List (CDRL), SEQ#301B. The CFSR will supply complete and timely funding data for the contract to the system manager. Delivered data will be in compliance with the Data Item Description (DID) to assure the adequate detail necessary for; (a) updating and forecasting contract funds requirements, (b) planning and decision making on funding changes in the contract, (c) developing fund requirements and budget estimates in support of the approved program, and (d) obtaining rough estimates of the contract termination costs. CFSR forecasts will reflect good business/financial management practices and procedures.

This subfactor is satisfied when the following standards are adequately met:

1. Contractual Requirement for Contract Funds Status Report (CFSR)

    a. The CFSR is prepared and submitted to the Air Force 25 calendar days after the close of the quarterly accounting period.

    b. The required number of copies are provided for Air Force distribution.

    c. Costs are segregated by Cost Plus Incentive Fee (CPIF) and Fixed Price (FP) contract line items at the Work Breakdown Structure (WBS) 1 level.

    d. Cumulative time periods are reported properly by month for 6 months, quarterly to the end of the current government fiscal year.

2. The data item description requirements (DI-F-6004B)

a. The initial negotiated contract target price and contract ceiling price (item 9) include only the share associated with the current fiscal year (item 3).

b. The adjusted contract price and ceiling (item 10) include only the share associated with current fiscal year (item 3).

c. The funding authorized to date (col C) includes the dollar amounts under the contract from the beginning of the contract through the current report date (item 6).

d. The "accrued expenditures plus open commitments total" (col D) includes accrued expenditures through the end of the reporting period and open commitments on the as-of-date of the report.

e. The "contract work authorized-definitized" (col E) includes the estimated price of the negotiated contract for the current fiscal year and only the contract changes which have been priced and incorporated in the contract.

f. The "contract work authorized-not definitized" (col F) includes only that work for which written orders have been received.

g. The "forecast-not yet authorized" includes the estimate for changes and proposals, including fee. The narrative remarks section includes all change documents and the estimated value of each.

h. The "open commitments" line includes accrued expenditures.

i. The accrued expenditures line includes:

(1) Actual payments for services or items

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[redacted]

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release, distribution unlimited
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) AFIT/GCM/LSY/89S-13	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION School of Systems and Logistics 6b. OFFICE SYMBOL *(If applicable)* AFIT/LSY	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS *(City, State, and ZIP Code)* Air Force Institute of Technology (AU) Wright-Patterson AFB OH 45433-6583	7b. ADDRESS *(City, State, and ZIP Code)*
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL *(If applicable)*	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS *(City, State, and ZIP Code)*	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. | PROJECT NO. | TASK NO | WORK UNIT ACCESSION NO.

11. TITLE *(Include Security Classification)*
A Case Study Of The Planning And Implementation Of Production Readiness Reviews For Selected Weapon Systems Within Air Force Systems Command

12. PERSONAL AUTHOR(S)
Harold D. Shirey, B.S., 1st Lt, USAF

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT *(Year, Month, Day)*	15. PAGE COUNT
MS Thesis	FROM ____ TO ____	1989 September	90

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS *(Continue on reverse if necessary and identify by block number)*
FIELD	GROUP	SUB-GROUP	Production Production Readiness Reviews Producibility Transition Acquisition
15	05		

19. ABSTRACT *(Continue on reverse if necessary and identify by block number)*

Thesis Advisor: Charles M. Farr, Major, USAF
Assistant Professor of Contracting Management

Approved for public release: IAW AFR 190-1.

Larry W. Emmelhainz

LARRY W. EMMELHAINZ, Lt Col, USAF 11 Oct 89
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Wright-Patterson AFB OH 45433-6583

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL Charles M. Farr, Major, USAF	22b. TELEPHONE *(Include Area Code)* (513) 255-4845 22c. OFFICE SYMBOL AFIT/LSY

DD Form 1473, JUN 86 *Previous editions are obsolete.* SECURITY CLASSIFICATION OF THIS PAGE

UNCLASSIFIED

Block 19

The purpose of this ~~study~~ thesis was to determine how Production Readiness Reviews (PRR) were planned, implemented, and managed by selected programs within Air Force Systems Command. In 1983, the Defense Science Board was tasked with reviewing ways to improve and accelerate the transition of weapon systems into production. During 1985, the General Accounting Office reviewed why some weapon systems encounter production problems while others do not. Both studies provided recommendations on ways to improve the transition process. However, new production programs continue to suffer significant production problems which invariably result in cost increases and schedule delays.

This study reviewed ten programs which recently conducted PRRs in an attempt to look at actual PRR practices and factors which influenced the selection of these practices. In addition, an attempt was made to determine whether recommendations from the DSB and GAO studies were implemented. Included in this study were reviews of PRR Plans, PRR Reports, Contract Statements of Work, and PRR briefings. In addition, key managers were interviewed for their views of the PRR process and recommendations for changes.

Based on the data from this study, it was apparent that all ten programs met the basic DOD requirements for PRR implementation. However, DOD Regulations and Directives did not provide sufficient guidance on planning and managing PRRs. The result was several different planning approaches that were generally dependent on program size, cost, and complexity. The degree of experience and expertise of program office personnel also played a significant role in PRR planning. The different approaches taken and the factors influencing these approaches are provided in Chapter III. Specific conclusions and recommendations are provided in Chapter IV.